Materials, Architecture and Prospects for Proton Conducting Ceramic based Metal Supported Cells

F. Han[1], N. Sata[1], R. Semerad[2], G. Schiller[1], R. Costa[1]

[1] German Aerospace Center (DLR), Institute of Engineering Thermodynamics, Pfaffenwaldring 38-40, D-70569 Stuttgart, Germany
[2] Ceraco, Ceramic Coating GmbH, Rote-Kreuz-Str. 8, D-85737 Ismaning, Germany

In the context of the energy transition, high temperature fuel cells and electrolysis cells are considered as a key technology for the future. As a replacement for oxygen ion conducting ceramics in solid oxide cells (SOC), high temperature proton conducting ceramics (HTPC) operating up to 600 °C change the paradigm by offering the possibility to perform hydrogenation or dehydrogenation of gases.
Nowadays, the mainstream planar proton conducting cells (PCC) rely on the so called anode supported fuel cell architecture, where the mechanical strength is provided by an anodic cermet made of nickel and proton conducting materials. However, the state-of-the-art proton conducting materials demonstrates insufficient mechanical strength in comparison to the conventional oxygen ion conducting materials, for instance yttria stabilized zirconia, and makes the upscaling and the stacking of the cells extremely difficult. On the contrary, the metal supported cell architecture offers intrinsically superior mechanical strength. Nonetheless, the fabrication of gas-tight electrolyte without a high temperature thermal treatment, typically at 1400°C, remains a key challenge for metal-supported cells.
In the European project EVOLVE (FCH JU Grant 303429 – 2012/2017), we have successfully demonstrated a metal supported SOC implementing a multilayer thin-film electrolyte (Figure 1) produced by PVD and manufactured at temperatures below 1000°C. Based on this experience, we propose to translate this architecture to planar MS PCCs. Here, we present the manufacturing strategy specifically designed for metal supported cells with thin-film HTPC electrolyte. Progress in the development of each compartment including the thin-film electrolyte and electrode materials, for both fuel and air side, will be given. Prospects and challenges will be discussed.

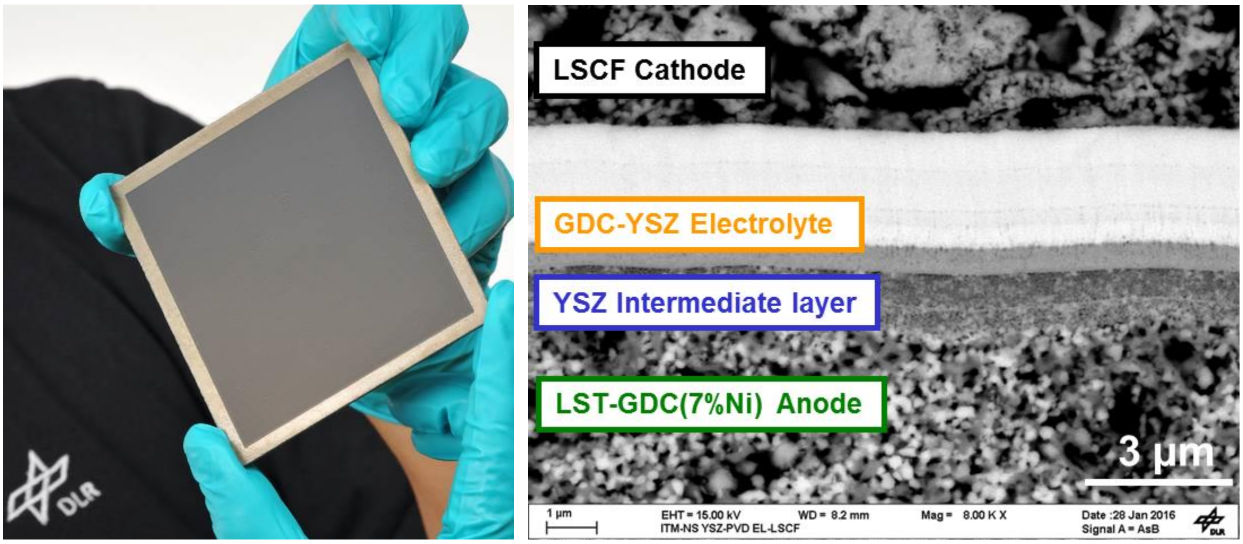

Figure 1. Advanced Metal Supported Solid Oxide Cell produced at DLR. Left: 90mm x 100mm cells, Right: SEM cross section of the cell showing details of the electrolyte structure